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November 13, 2000

Beth Brown-Walden
Remedial Project Manager
USEPA Region IV
61 Forsyth Street
Atlanta, Georgia 30303-8960

John Warren
USEPA (2811R)
1200 Pennsylvania Avenue NW
Washington, DC 20460

Subject: Carrier Collierville Site – Soil Confirmation Sampling Work Plan

Ms. Brown-Walden and Mr. Warren:

Per our conversations earlier this month, I am submitting for your review one copy of the Carrier Collierville Site *Soil Confirmation Sampling Work Plan.*

As we discussed, Carrier is moving forward with its intent to sample soil in areas currently under remediation, with the objective of determining whether the two SVE systems onsite have met the soil remediation goal. Before Carrier proceeds with the soil borings described in this plan, Carrier requests that you review the sampling strategy and the statistical approach outlined for data evaluation.

If you have any questions or comments regarding the this work plan, please do not hesitate to contact me at 901/-372-7962.

Respectfully Submitted,

EnSafe Inc.

by: Lori Anne Goetz
Technical Services

cc: Jordan English, TDEC
Bryan Kielbania, UTC
Frank Sizemore, Carrier

Draft Soil Confirmation Sampling Work Plan Carrier Corporation Collierville, Tennessee

EnSafe Project No.
3133-012

Prepared for:

Carrier Corporation
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Prepared by:

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November 13, 2000

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1.0 INTRODUCTION

This plan describes sampling and analysis procedures required to confirm effectiveness of soil vapor extraction (SVE) which is being conducted at the Carrier Collierville CERCLA site. Soil will be sampled and analyzed under this plan to verify performance of the soil remedy. The United States Environmental Protection Agency (USEPA) Region IV- Environmental Compliance Branch, *Environmental Investigations Standard Operating Procedures and Quality Assurance Manual*, May 1996 (USEPA SOP/QAM) was used as a basis for these sampling procedures.

The cleanup standard for the trichloroethene (TCE)-contaminated soil is 0.533 milligrams per kilogram (mg/kg) or until EPA's determination that contaminant concentrations have ceased to decline over time, and are remaining constant at some statistically significant level above remediation levels in the area of remediation, as verified by soil sampling.

Basis for Remedial Goal

The soil remediation goal was derived from modeling of the partitioning of soil contamination to shallow groundwater, and the transport of shallow groundwater contaminants to the underlying Memphis Sand aquifer. As documented in the Remedial Investigations, (RI; EnSafe, 1992) MULTIMED was used to model contaminant transport from source area soil to the drinking water aquifer. Primary assumptions included the following:

- Source area size — 20,000 square meters (or approximately 5 acres)
- Source area thickness — 15.2 meters (approximately 50 feet)
- Distance to receptor (e.g., Memphis Sand aquifer) — 100 meters (approximately 330 feet)

Compliance with the standard is expected to be one of average. In other words, the vadose soil TCE concentration is to be lowered to, on average, 0.533 mg/kg to prevent further contamination of the Memphis Sand above 5 micrograms per liter (μg/L).

2.0 SOIL VAPOR EXTRACTION SAMPLING ACTIVITIES

2.1 Soil Sampling and Analysis

There are two SVE remediation systems for the Carrier Collierville site, the North Remediation Site (NRS) system and the Main Plant Area (MPA) remediation system. The NRS remediation area has been active since 1989. The MPA remediation area has been operational since March 1995. Sampling is planned for both areas to confirm that the remediation goal of 0.533 mg/kg has been achieved.

2.1.1 Sampling Plan: North Remediation Site

The NRS SVE operating data indicate that diffusion of contaminants is controlling the removal rate, especially in the shallow soils. RI data are presented in Figure 2-1 as a baseline for comparison.

1996/1997 Soil Sampling Events

The last soil sampling event was performed in December 1996 to determine the progress made during site remediation. Boring locations and results are shown on Figure 2-2. One sample was collected per 5-foot interval, to a terminal depth of 45 feet bgs. Nine intervals were sampled for each boring location. These data indicated that, out of 36 sample intervals, only two samples exceeded the 0.533 mg/kg criterion: NRS-SB2, at the 15-foot interval (130 mg/kg), and NRS-SB3, at the 20-foot interval (1.1 mg/kg). All other intervals sampled were below the remediation criterion.

A supplemental sampling event was performed in March 1997 to confirm these results, targeting the 15-foot interval at NRS-SB2. Eight direct push technology (DPT) borings were completed (G1 through G8), with samples collected at the 10- to 12-foot, 13- to 15-foot, and 16- to 18-foot intervals. Twenty-four samples were collected, five of which exceeded the 0.533 mg/kg criterion: G1 (1.4 mg/kg, in the 10- to 12-foot interval), G2 (21 mg/kg, in the 16- to 18-foot interval),

RW-1

RW-9

RW-4

B18

SAMPLE INTERVAL	CONCENTRATION (ppm)
3-5	16
13-15	2.1
18-20	0.13

RW-6

B19

SAMPLE INTERVAL	CONCENTRATION (ppm)
3-5	0.840
13-15	0.920
18-20	0.010

RW-5

B40

SAMPLE INTERVAL	CONCENTRATION (ppm)
3-5	1.890
8-10	0.114
13-15	0.021
18-20	0.037
23-25	0.080
28-30	1.230

RW-8

RW-3

B17

SAMPLE INTERVAL	CONCENTRATION (ppm)
0.5-2	15
13-15	168
18-20	0.960

RW-7

RW-2

8 0 8

SCALE FEET

LEGEND

- ⊙ – SHALLOW EXTRACTION WELL
- ◓ – DEEP EXTRACTION WELL
- ○ – SOIL BORING

NOTE: 1 BORINGS B17, B18, B19, AND B40 WERE COMPLETED DURING THE RI.

2 CONCENTRATIONS ARE SHOWN IN PARTS-PER-MILLION (ppm) OR MILLIGRAMS PER KILOGRAM (mg/kg).

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FIGURE 2-1
NORTH REMEDIATION SYSTEM
RI DATA
CARRIER CORPORATION
COLLIERVILLE, TN

DWG DATE:11/06/00 | DWG NAME:3133W018

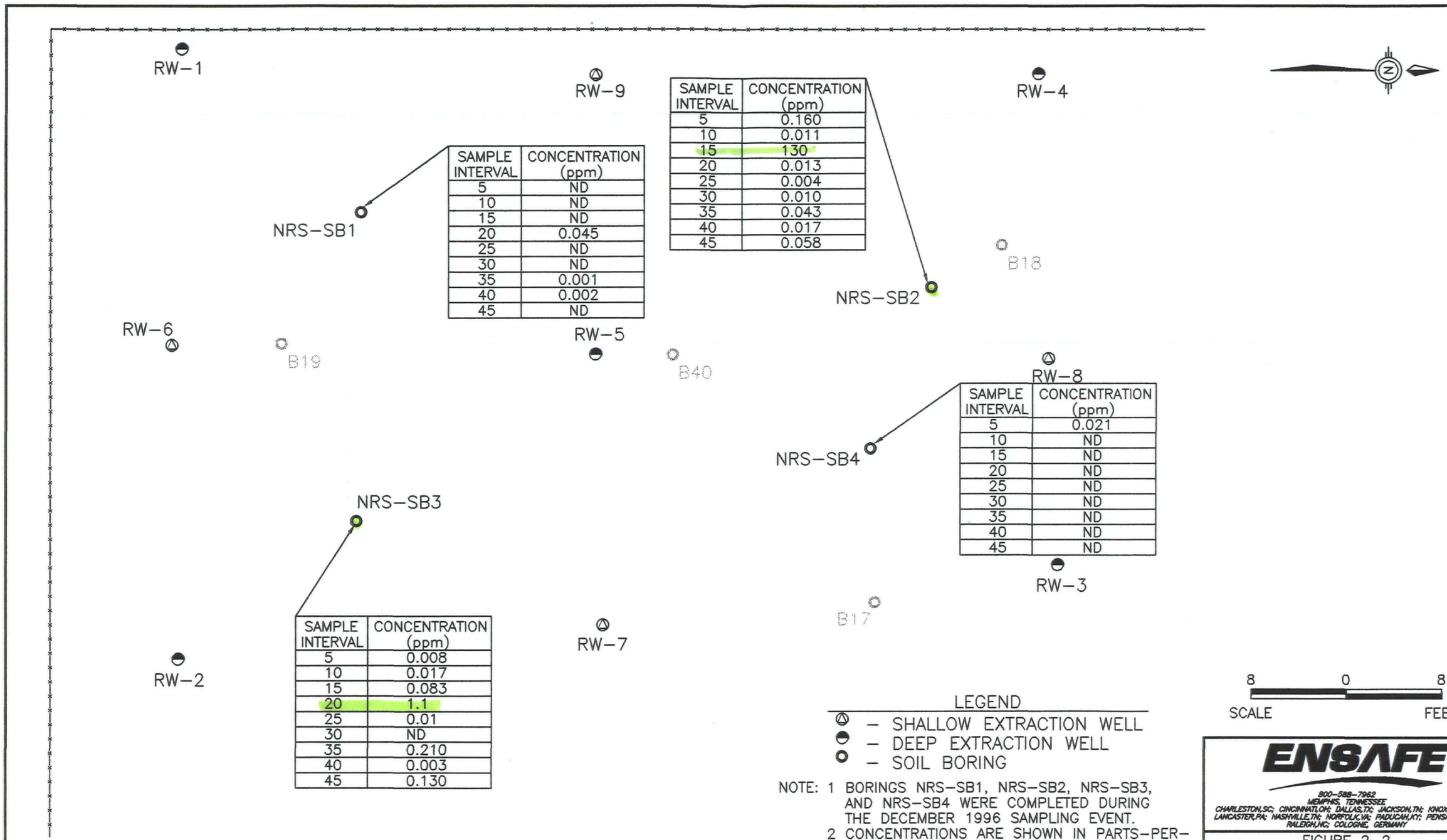
RW-1
RW-9
RW-4
RW-6
RW-5
RW-8
RW-3
RW-2
RW-7
B19
B40
B18
B17
NRS-SB1
NRS-SB2
NRS-SB3
NRS-SB4
SAMPLE INTERVAL | CONCENTRATION (ppm)
5 | ND
10 | ND
15 | ND
20 | 0.045
25 | ND
30 | ND
35 | 0.001
40 | 0.002
45 | ND
SAMPLE INTERVAL | CONCENTRATION (ppm)
5 | 0.160
10 | 0.011
15 | 130
20 | 0.013
25 | 0.004
30 | 0.010
35 | 0.043
40 | 0.017
45 | 0.058
SAMPLE INTERVAL | CONCENTRATION (ppm)
5 | 0.008
10 | 0.017
15 | 0.083
20 | 1.1
25 | 0.01
30 | ND
35 | 0.210
40 | 0.003
45 | 0.130
SAMPLE INTERVAL | CONCENTRATION (ppm)
5 | 0.021
10 | ND
15 | ND
20 | ND
25 | ND
30 | ND
35 | ND
40 | ND
45 | ND
LEGEND
– SHALLOW EXTRACTION WELL
– DEEP EXTRACTION WELL
– SOIL BORING
NOTE: 1 BORINGS NRS–SB1, NRS–SB2, NRS–SB3, AND NRS–SB4 WERE COMPLETED DURING THE DECEMBER 1996 SAMPLING EVENT.
2 CONCENTRATIONS ARE SHOWN IN PARTS–PER–MILLION (ppm) OR MILLIGRAMS PER KILOGRAM (mg/kg).
8 0 8
SCALE FEET
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FIGURE 2–2
NORTH REMEDIATION SYSTEM
DECEMBER 1996 DATA
CARRIER CORPORATION
COLLIERVILLE, TN
DWG DATE:11/06/00
DWG NAME:3133W019

G6 (0.69 mg kg, in the 13- to 15-foot interval), and G8 (3.3 mg/kg in the 13- to 15-foot interval, and 0.54 mg/kg in the 16- to 18-foot interval). These results are shown in Figure 2-3.

Sampling performed in 1996 and 1997, then, identified residual contamination in the northwest quadrant of the NRS, around NRS-SB2; this area is approximately 25 feet by 50 feet, or 1,250 square feet (0.03 acre). The zone exhibiting contamination at NRS-SB2 above the site cleanup goal was identified between 10 and 20 feet bgs. A maximum in-place volume of 465 cubic yards of contaminated soil is estimated to surround NRS-SB2, with an estimated mass of approximately 180 lbs. Contamination above the 0.533 mg/kg criterion was also quantified at NRS-SB3, in the zone between 15 and 25 feet bgs. The area represented by NRS-SB3 is also approximately 1,250 square feet. A maximum in-place volume of 465 cubic yards of contaminated soil is estimated to surround NRS-SB3, with an estimated mass of approximately 2 pounds. As noted in Section 1, the basis for the soil cleanup goal assumes a large source area (20,000 square meters, or approximately 6 acres). The residual impacted area at NRS is, therefore, significantly smaller than the source defined during the development of the 0.533 mg/kg criterion.

Groundwater monitoring wells near the NRS have been dry for several years, indicating that the target migration pathway (via shallow groundwater to the Memphis Sand) is incomplete. Again, as noted in Section 1, the soil cleanup goal was developed for the MPA, which assumes a relatively short distance to the downgradient receptor well (100 meters). If groundwater was present at the NRS, contaminant transport (and associated attenuation) would occur over an additional 160 meters before groundwater reached the northern edge of the MPA.

Despite the fact that the areas exceeding the 0.533 mg/kg are extremely small, and the mass remaining represents less than 2% of the total mass removed at the NRS since operation began in 1989 (over 11,000 lbs), Carrier continued operation of the NRS to remove additional mass. Operation of the NRS was enhanced in 1997. The regenerative blower was replaced with a

RW-1

RW-9

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.023
15	0.028
18	21

G2

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	1.4
15	0.011
18	0.003

RW-4

G4

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.21
15	0.062
18	0.009

G1

NRS-SB1

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.088
15	0.012
18	0.008

G8

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.063
15	3.3
18	0.54

B18

G7

NRS-SB2

G3

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.039
15	0.120
18	0.073

RW-6

B19

RW-5

B40

G5

G6

RW-8

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.008
15	0.008
18	0.003

NRS-SB4

SAMPLE INTERVAL	CONCENTRATION (ppm)
12	0.006
15	0.69
18	0.024

NRS-SB3

RW-3

B17

RW-7

RW-2

8 0 8

SCALE FEET

LEGEND

- SHALLOW EXTRACTION WELL
- DEEP EXTRACTION WELL
- SOIL BORING

NOTE: 1 BORINGS G1 THROUGH G8 WERE COMPLETED DURING MARCH 1997.

2 CONCENTRATIONS ARE SHOWN IN PARTS-PER-MILLION (ppm) OR MILLIGRAMS PER KILOGRAM (mg/kg).

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FIGURE 2-3
NORTH REMEDIATION SYSTEM
MARCH 1997 DATA
CARRIER CORPORATION
COLLIERVILLE, TN

DWG DATE:11/07/00 | DWG NAME:3133W020

positive displacement blower capable of increased vacuum pressure, and flow was concentrated (by valve alignment) on shallow extraction wells.

Proposed Sampling Methodology

To evaluate whether soil in the targeted intervals still exceed the remediation goal, 11 borings are proposed near NRS-SB2, and 3 borings are proposed near NRS-SB3. Samples will be collected from the interval identified during the December 1996 event as exceeding the 0.533 mg/kg criterion, plus the intervals immediately above and below. These intervals are:

NRS-SB2	NRS-SB3
10	15
15 (target interval)	20 (target interval)
20	25

Figure 2-4 shows the location of each boring. Based on the December 1996 sampling results, all other intervals and locations are assumed to meet the remediation goal. All samples will be collected using EnCore samplers, and analyzed using SW-846 Method 8260B for volatile organics. Data will be evaluated using the methodology presented in *USEPA Publication No. SW-846, third edition, (Part III), Chapter 9 — Sampling Plan.* This evaluation will employ a probability level (confidence interval) of 80%. That is, for the parameter contaminant of concern (TCE), a confidence interval will be described within which the mean of the results occurs, if the sample were representative. The upper limit of the CI will then compared with the 0.533 mg/kg criterion.

2.1.2 Sampling Plan: Main Plant Area Remediation

A total of 7 confirmatory borings will be completed at the remediation area to verify that remediation has been achieved. The locations of these borings will be biased so that samples will be collected in the area of highest contaminant concentration prior to remediation, biased toward locations expected to exhibit stagnation or low air exchange rates (likely to be the last to be extracted under normal operation of the vapor extraction system).

RW-1

RW-9

RW-4

G2

G4

G1

G8

NRS-SB1

B18

G7

NRS-SB2

G5

G3

RW-6

RW-5

B19

G6

B40

RW-8

NRS-SB4

NRS-SB3

RW-3

B17

RW-7

RW-2

LEGEND

- ⊘ – SHALLOW EXTRACTION WELL
- ◓ – DEEP EXTRACTION WELL
- ○ – SOIL BORING
- ● – PROPOSED CONFIRMATION SAMPLING LOCATION

NOTE: 1 BORINGS B17, B18, B19 AND B40 WERE COMPLETED DURING THE RI.
2 BORINGS NRS-SB1, NRS-SB2, NRS-SB3, AND NRS-SB4 WERE COMPLETED DURING THE DECEMBER 1996 SAMPLING EVENT.
3 BORINGS G1 THROUGH G8 WERE COMPLETED DURING THE MARCH 1997 SAMPLING EVENT

8 0 8

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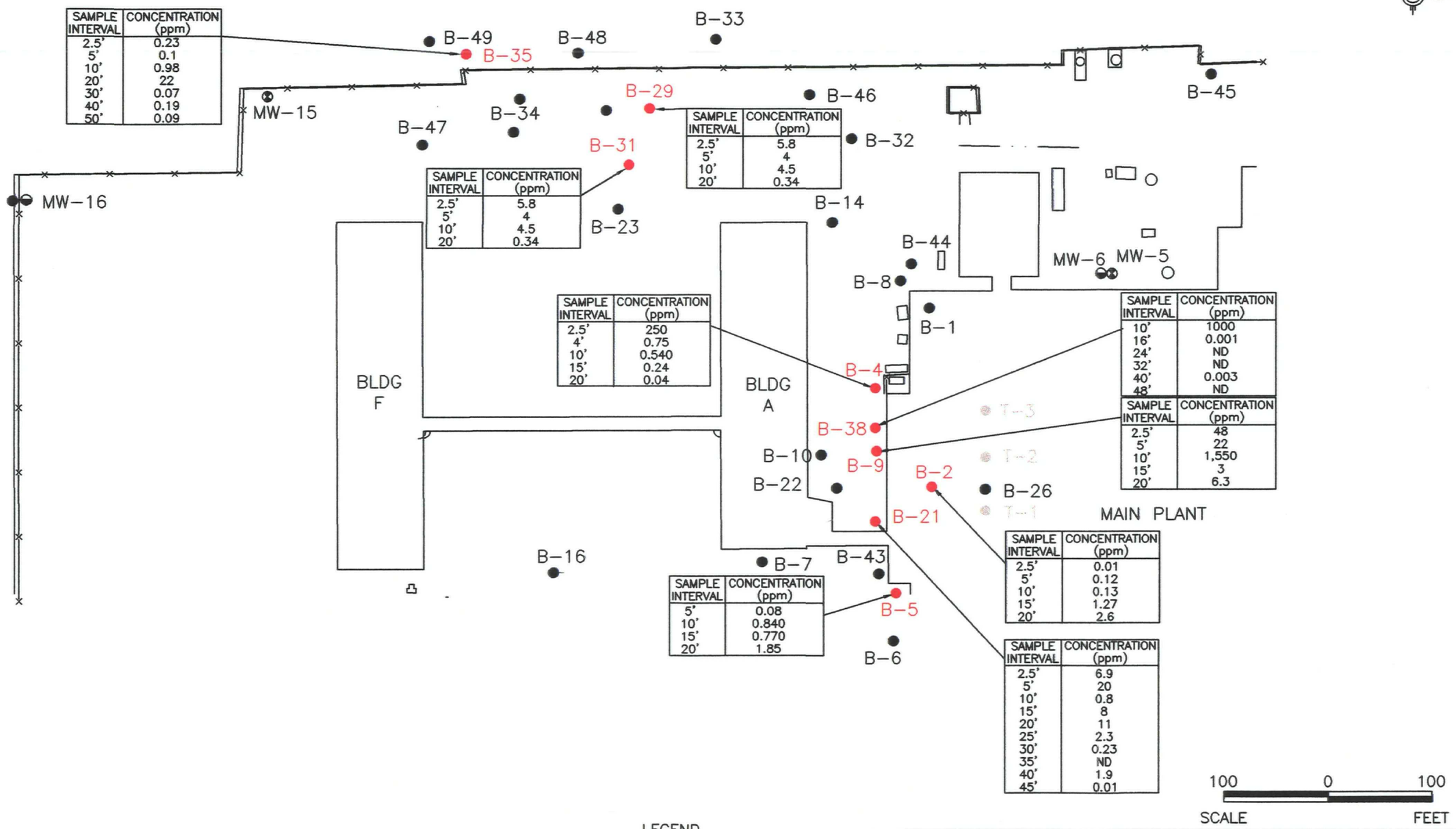
FIGURE 2-4
NORTH REMEDIATION SYSTEM
PROPOSED CONFIRMATORY
BORING LOCATIONS
CARRIER CORPORATION
COLLIERVILLE, TN

DWG DATE:11/08/00 | DWG NAME:3133W015

Sample results from the remedial investigation are shown in Figure 2-5, and primarily indicate TCE exceedances along the southern boundary of the Main Plant Building. Soil was sampled again during remedial design (RD), concurrent with installation of vapor test wells. RD results, from 1994, are shown on Figure 2-6. RD data suggested significant attenuation, such that outlying areas exhibited decreased concentrations below the 0.533 mg/kg goal. In most locations, all located in the area now known as the MPA, contaminant mass was concentrated in the upper 10 to 15 feet of the soil column, with concentrations less than the remediation criterion below this depth.

Proposed confirmatory sampling locations are shown on Figure 2-7. These specific locations are equidistant from adjacent shallow vertical extraction wells, and between horizontal wells in shallow and deep soil immediately adjacent to the former degreaser room. Four borings will be installed to a depth of approximately 25 feet bgs. Three borings will be installed to a depth of 50 feet bgs. One sample will be collected at the base of every 5-foot interval. All samples will be collected using EnCore samplers, and analyzed using SW-846 Method 8260B for volatile organics.

Sample statistics will be calculated using the methodology presented in *USEPA Publication No. SW-846, third edition, (Part III), Chapter 9 — Sampling Plan*. Although proposed sample locations are biased toward worst-case concentrations within the sample space, this analysis can be used as a tool for drawing conservative conclusions about the true nature of the entire zone of soil impacted by TCE. A confidence interval of 80% will be determined using the MPA dataset. The upper bound of this confidence interval will then compared with the 0.533 mg/kg criterion.



SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	0.23
5'	0.1
10'	0.98
20'	22
30'	0.07
40'	0.19
50'	0.09

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	5.8
5'	4
10'	4.5
20'	0.34

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	5.8
5'	4
10'	4.5
20'	0.34

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	250
4'	0.75
10'	0.540
15'	0.24
20'	0.04

SAMPLE INTERVAL	CONCENTRATION (ppm)
10'	1000
16'	0.001
24'	ND
32'	ND
40'	0.003
48'	ND

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	48
5'	22
10'	1,550
15'	3
20'	6.3

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	0.01
5'	0.12
10'	0.13
15'	1.27
20'	2.6

SAMPLE INTERVAL	CONCENTRATION (ppm)
5'	0.08
10'	0.840
15'	0.770
20'	1.85

SAMPLE INTERVAL	CONCENTRATION (ppm)
2.5'	6.9
5'	20
10'	0.8
15'	8
20'	11
25'	2.3
30'	0.23
35'	ND
40'	1.9
45'	0.01

NOTE:

1. RI DATA COLLECTED 1989/1990
2. TCE CLEANUP GOAL 0.533 ppm (OR mg/kg)
3. ND = NOT DETECTED

LEGEND

- ● – SOIL BORING BELOW CLEAN UP GOAL
- ⊗ – MONITORING WELL
- ● – SOIL BORING ABOVE CLEAN UP GOAL
- ● – NO DATA

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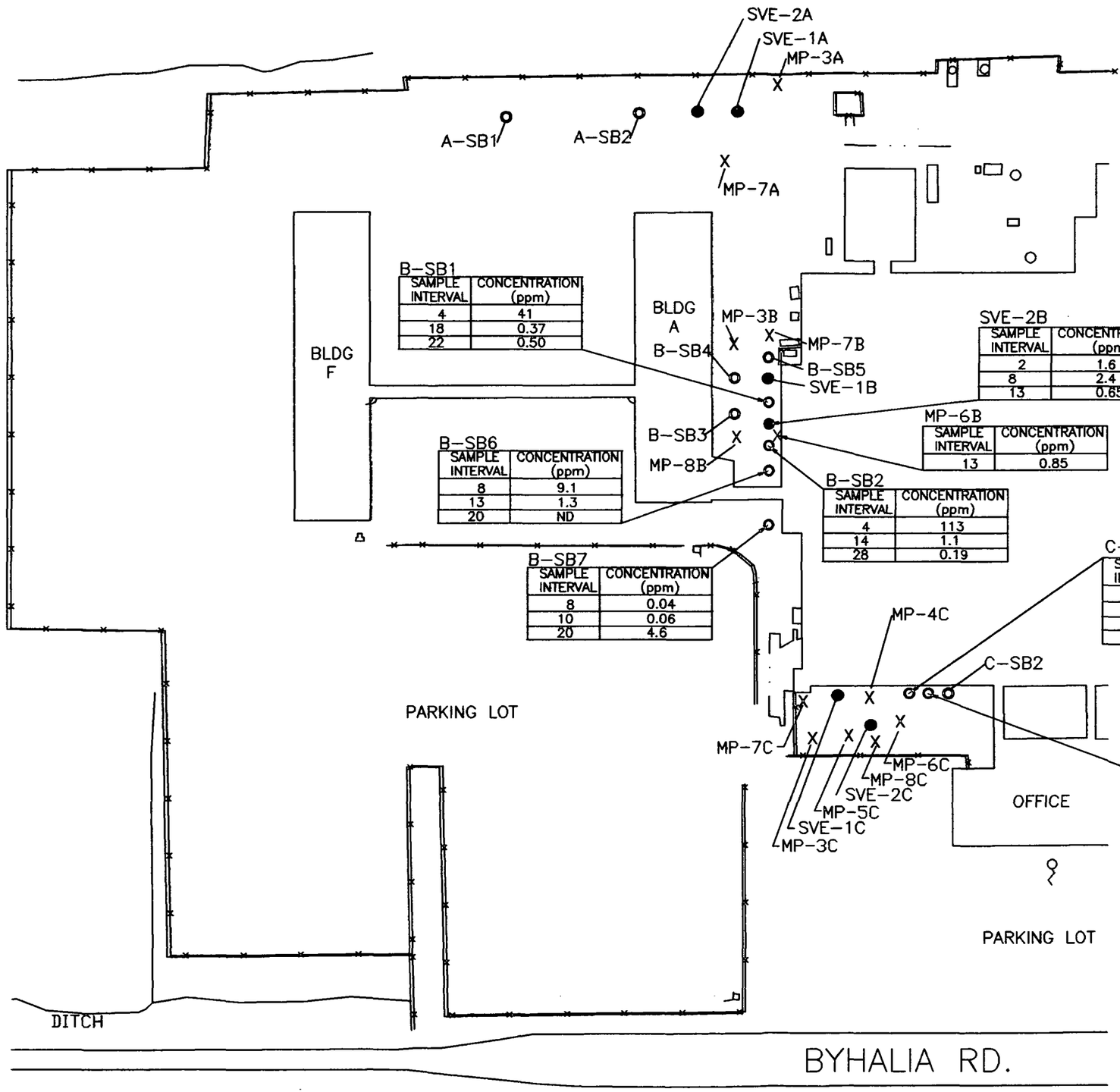
FIGURE 2-5
MAIN PLANT AREA
RI DATA – TCE EXCEEDANCES
CARRIER CORPORATION
COLLIERVILLE, TN

DWG DATE: 11/08/00 | DWG NAME: 3133W016



LEGEND

SOIL BORING BELOW CLEANUP GOAL

SOIL BORING ABOVE CLEANUP GOAL

NOTES

1. SOIL DATA COLLECTED DURING MPA DESIGN (1994).
2. TCE CLEANUP GOAL 0.533 ppm (OR MG/KG)
3. ND = NOT DETECTED

100 0 100

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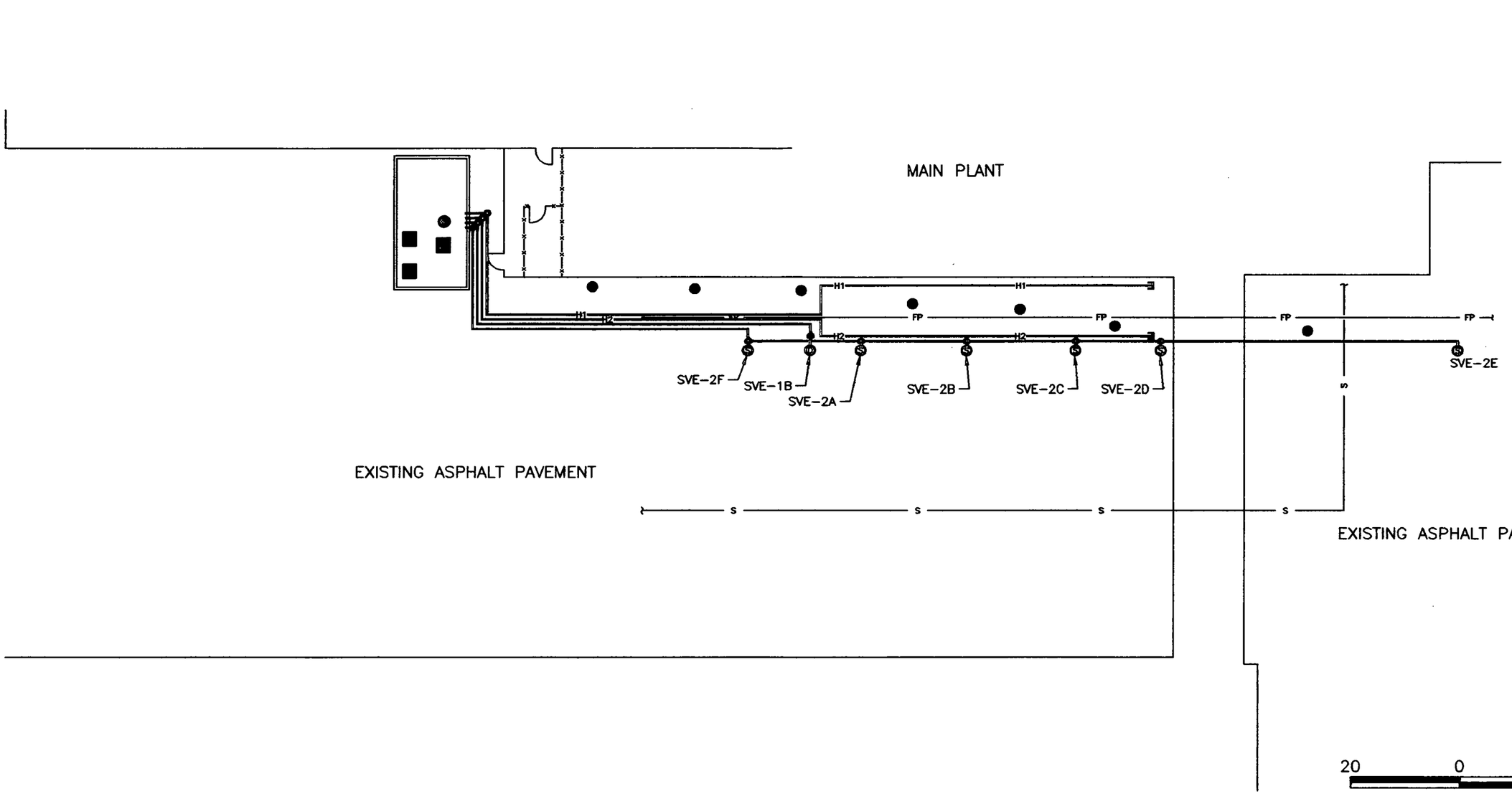
LITTLE ROCK,AR JACKSON,MS CLEVELAND,OH

FIGURE 2-6
MAIN PLANT AREA
DESIGN DATA - TCE EXCEEDANCES
CARRIER CORPORATION
COLLIERVILLE, TN

DWG DATE: 11/10/00 | DWG NAME: 3133B006



20 0 20

SCALE FEET

LEGEND

- CHAIN LINK FENCE
- FP — FIRE PROTECTION PIPING (EXISTING)
- S — SEWER PIPING (EXISTING)
- AIR MANIFOLD PIPING (NEW)
- DEEP VAPOR EXTRACTION WELL
- SHALLOW VAPOR EXTRACTION WELL
- H — HORIZONTAL EXTRACTION PIPING (NEW)
- PROPOSED CONFIRMATION BORING LOCATION

NOTE:
ACTUAL LOCATIONS WILL BE DETERMINED IN THE FIELD.

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LITTLE ROCK,AR JACKSON,MS CLEVELAND,OH

FIGURE 2-7
PROPOSED CONFIRMATORY
SOIL BORING LOCATIONS
MAIN PLANT AREA
CARRIER CORPORATION, COLLIERVILLE, TN

DWG DATE: 11/08/00 | DWG NAME: 3133W017

3.0 QUALITY CONTROL SAMPLING

The following Quality Assurance Project Plan (QAPP) outlines quality assurance/quality control (QA/QC) management practices to ensure the validity of data produced through all field activities and quality goals for the analytical method to be employed.

3.1 QA Objectives

The general QA objectives of this project are to assess and document the precision, accuracy, representativeness, completeness, and comparability of all sampling and analyses performed. Quality criteria are set herein to assure suitability for intended use of data obtained during the project and to meet project goals. The following discusses in detail data QA criteria and goals specific to this project. To facilitate an understanding of how these objectives will be achieved, definitions of each of these criteria are presented.

3.1.1 Precision

Precision measures the reproducibility of measurements and methods, and is defined for qualitative data as a group of values' variability compared with its average value. To assess the precision of the measurement systems used in this project, field duplicates will be obtained and analyzed with the samples collected. Precision of laboratory analysis will be assessed by comparing the analytical results between Matrix Spike and Matrix Spike Duplicates (MS/MSDs) and laboratory control sample/laboratory control sample duplicates (LCS/LCDs). The relative percent difference (%RPD) will be calculated for each pair of duplicate analysis using the following equation:

$$\% \ RPD = \frac{S - D}{(S + D)/2} \ x \ 100$$

Where:

S = sample result
D = duplicate result

3.1.2 Accuracy

Accuracy is the degree to which a given result agrees with the true value. The accuracy of an entire measurement system is an indication of any bias that exists. Spiked sample results provide information needed to assess the accuracy of analyses. Specifically, surrogate spike, MS/MSD, and LCS/LCSD percent recoveries are used to assess accuracy. Every sample is spiked with known quantities of nontarget surrogate compounds. Five percent of all samples analyzed are spiked with target chemicals for the MS/MSD. If the calculated %Rs for the known spike concentrations are within defined control limits set by each method, the reported sample concentrations are considered accurate.

$$\% R = \frac{(SSR-SR)}{SA} x 100$$

Where:

SSR	=	spike sample recovery
SR	=	sample recovery
SA	=	concentration of spike added

3.1.3 Representativeness

Representativeness expresses the degree to which data accurately and precisely represent a characteristic of a population, parameter variations at a sampling point, a process condition, or an environmental condition. Representativeness is a qualitative parameter which is dependant upon the proper design of the sampling program and proper laboratory protocol. The sampling approach was designed to provide data representative of site conditions. During development of this approach, consideration is given to past analytical data, physical setting, and processes previously and currently used at the facility. The sampling approach was discussed in the previous section. Representativeness will be satisfied by insuring that the Work Plan, QAPP, and USEPA protocols are followed, proper sampling technique is used, proper analytical procedure is followed, and holding times of the samples are not exceeded by the laboratory.

3.1.4 Completeness

Completeness is defined as the percentage of measurements judged to be valid. The completeness goals for this project are set at 95% for laboratory analysis. Completeness goals of field measurements reflect the ability to resample immediately, prior to declaring well stability and obtaining samples for subsequent analysis. Data completeness will be expressed both as the percentage of total tests conducted that are deemed valid and as the percentage of the total tests required in the scope of work that are deemed valid.

3.1.5 Comparability

Comparability is the degree to which one data set can be compared to another. The objective of this QA/QC plan is to produce a high level of comparability between data sets. Heterogeneous investigative samples make it difficult to obtain consistently high comparability values. However, the use of standard methods for sampling and analysis (USEPA protocols), reporting data in standard units, and using standard and comprehensive reporting formats will optimize the potential for high levels of data comparability.

3.2 Daily Logs (Field Log)

A field log will be maintained as the primary documentation of the actual site conditions and field activities. It will be maintained concurrently with the conduct of the field activities by the Site Manager or his/her designee. Specific information to be included in the field log includes, among other things:

- Date, time, and description of site conditions.
- Date, time, and description of work activities.
- Names of team members present.

- Names, time of arrival, and time of departure of any visitors.

- Number, type, date, time, and identification of any samples collected.

- Records of field measurements, including calibration data and reference to corresponding sample identification numbers.

- Health and Safety data, including site data (e.g., organic vapor, explosimeter, oxygen, etc.), measurements, and any deviation from established standard operating procedures.

- Any unusual circumstances or occurrences.

The field log will consist of a bound, waterproof log book containing numbered pages. Entries will be made in the field log using waterproof ink. As with all data log books, no pages will be removed for any reason. When corrections or revisions are necessary, these will be made by drawing a single line through the original entry in such a manner that the original entry remains legible. Corrections will then be made along side or above the original entry. All corrections and revisions will be initialed and dated by the individual making them.

At the completion of the filed activities, the field log will be returned to the Project Manager as a part of the permanent project record.

3.3 Sample Collection

Field measurements should be taken only by personnel trained to use the appropriate and available equipment. Field investigators must be trained and evaluated for overall knowledge of field measurement techniques by qualified staff before using the equipment. Sample collection should also be performed only by personnel knowledgeable of the QA objectives. The primary measurements of both field and laboratory QA/QC are derived from MS/MSDs, duplicate samples, field blanks, and rinsate blanks collected in the field.

3.3.1 Trip Blanks

A trip blank is a sample container filled with organic-free water that is transported unopened with the sample bottles. It is opened in the laboratory and analyzed along with the field samples for volatile constituents of interest. One trip blank for volatile parameters will be prepared and submitted to the laboratory with each shipment.

3.3.2 Equipment Rinsate and Field Blanks

Equipment rinsate blanks are collected by retaining rinsate from sampling equipment. Field sampling apparatus (bailer, pump tubing, etc.), is rinsed with organic-free deionized or distilled water after full decontamination procedures have been completed. Rinsate blanks are collected in containers of the same type and treatment as the sample containers. One rinsate blank will be collected at a frequency of one per 20 samples collected.

A field blank is a sample container filled with the source water used in the decontamination of field equipment. The field blank is prepared, preserved and stored in the same manner as the other field samples. Field blanks are analyzed for contamination imparted by containers or other external sources. The blank is collected, preserved, and sealed in the same manner as other samples. One field blank will be submitted for each sampling event any time source water is changed.

3.3.3 Duplicate Samples

Duplicate samples are prepared by splitting a routine sample into two aliquots from the same source. Each aliquot is then placed in a separate sample container and shipped to the laboratory for analysis. Duplicate samples are handled, packaged, shipped, and analyzed in the same manner as are the routine samples.

The types of duplicates used will depend on the part of the measurement system to be evaluated for precision. Field duplicated samples analyzed by the same laboratory will yield information about sampling method precision and matrix homogeneity. Laboratory duplicated samples give an indication of sample preparation and analytical method precision.

For this soil sampling, precision will be assessed by evaluating results of duplicate and spike samples. Accuracy will be assessed by evaluating field blanks, and trip blanks. Table 3-1 summarizes QC sampling frequencies.

Table 3-1
Quality Control Sample Collection Frequency

Quality Control Sample	Frequency of Collection	Additional Sample Volume Required
Duplicate Samples	5% (One Duplicate sample for 20 investigative samples)	No extra volume is required for soil.
Equipment Rinsate Blanks	5% (One equipment rinsate blank for every 20 investigative samples)	Standard volume
Field blanks	One per sampling event	Standard volume
Trip Blank	One per cooler	Standard volume

Based on the number of soil boring samples and the QC sample collection frequency requirements, a total of 115 samples will be analyzed. Table 3-2 shows a breakdown of the number of soil samples that will be taken; Table 3-3 shows the number of QC samples required.

Table 3-2
Analysis and Sample Breakdown

Location	Number of Borings	Number of Soil Samples
NRS		
Near NRS-SB2 (10 to 25 feet)	11	33
Near NRS-SB3 (15 to 30 feet)	3	9
MPA		
Silt Zone Only (0 to 30 feet)	4	24
Silt and Sand Zones (0 to 50 feet)	3	30

Table 3-3
Analysis and Sample Breakdown

Location	Laboratory Analysis	Number of Soil Samples	Duplicates (1/20)	Trip Blanks (daily)	Field Blanks (1/event)	Equipment Rinsate Blanks (1/20)	Total Samples
NRS	VOCs	44	3	2	1	3	53
MPA	VOCs	54	3	2	0	3	62

4.0 FIELD PROCEDURES

This section describes the procedures for confirming achievement of the remediation goal.

4.1 Sample Collection

A new pair of nitrile disposable gloves will be donned before collecting each soil sample. Using 2-inch outer diameter, 5-foot-long, stainless steel split spoons, soil samples will be collected continuously ahead of the augers beginning at 5 feet below ground surface (bgs). Split spoons may be hydraulically pushed or hammered at the site geologist's discretion. Contents of all auger spoils will be containerized in 55-gallon drums.

Soil samples will also be collected using EnCore® samplers for VOCs by SW-846 Method 8260. The EnCore® samplers and analytical methodology stated in SW-846 Method 8260 minimizes open-air handling of soil samples. The EnCore® system consists of a T-shaped handle which holds a disposable sample container. The sample container will be affixed to the T-handle, then pushed into the soil core. As the sampler is pushed into the soil core, a spring loaded plunger is pushed back, allowing the sample to fill the container and preventing trapped air pockets. Once full, the sampler will be sealed with a locking, air tight cap. The sampler will then be removed from the handle. The EnCore® sampler will be handled like any other sample container.

Three EnCore® samples will be collected from each interval to be analyzed for VOCs using SW-846 Method 8260B. Two samplers will be used for low level analysis and one sampler will be used for high level analyses, in the event that the low level sample requires dilution. In addition, a bulk soil jar will be collected from every interval for the determination of percent moisture. Samples will be shipped overnight to the lab for analysis within 48 hours. If analysis within 48 hours is not possible, the laboratory will preserve the sample allowing for a 14-day holding time. If preservation is required, the laboratory will test a portion of the soil from the bulk jar to assess whether the soil reacts with sodium bisulfate used in preserving soil samples. If the sodium bisulfate does not react with the soil, the laboratory will preserve two (2) Encore®

volumes in sodium bisulfate and one (1) EnCore® volume in methanol. If sodium bisulfate produces a reaction with the soil (i.e., bubbling), the laboratory will place two (2) Encore® volumes in water and one (1) EnCore® volume in methanol.

4.2 Decontamination

Soil sampling equipment will be decontaminated before and between samples using the decontamination procedures listed below.

1. Don a new pair of disposable latex gloves before handling sampling equipment to be decontaminated.

2. Wash with tap water and laboratory detergent.

3. Rinse with tap water.

4. Rinse thoroughly with deionized water.

5. Rinse thoroughly with organic-free water and allow to air dry. ***It is important that any sampling equipment is completely dry to prevent any water from being introduced into the sample containers during sampling.***

6. Wrap with aluminum foil, or place in plastic bag to prevent contamination.

The drill rig will be steam cleaned and wire brushed before being brought onsite. The drill rig will then be inspected to ensure no oil, grease, hydraulic fluid, etc., are leaking. Drilling equipment will be decontaminated at the onsite decontamination pad between drilling of each boring using the decontamination procedures listed below.

1. Don a new pair of disposable nitrile gloves before handling equipment to be decontaminated.

2. Steam-clean with a pressure washer using tap water and laboratory detergent to remove particulate matter and surface film.

3. Pressure rinse with tap water.

4. Rinse thoroughly with deionized water.

5. Rinse thoroughly with organic-free water and allow to air dry.

6. Wrap with polysheeting to prevent contamination.

All non-dedicated stainless-steel sampling equipment and the split-spoon samplers will be decontaminated between boreholes using the procedures listed below.

1. Don a new pair of disposable nitrile gloves before handling sampling equipment for decontamination.

2. Steam clean with a pressure washer using tap water and laboratory detergent to remove particulate matter and surface film.

3. Rinse thoroughly with tap water.

4. Rinse thoroughly with deionized water.

5. Rinse with organic-free water and air dry.

6. Sampling equipment will be wrapped in aluminum foil until ready for use. Non-sampling equipment may be wrapped in plastic to avoid contamination.

5.0 SAMPLE MANAGEMENT

Sample management will consist of sample labeling, chain-of-custody seals and records, and associated field documentation procedures. The purpose of these procedures will be to ensure the quality of the samples is maintained during their collection, transportation, storage and through analysis to the final data deliverables. All sample management documentation and sample handling protocols have been developed using, as guidance, the EPA Region IV-Environmental Compliance Branch *Standard Operating Procedures and Quality Assurance Manual, (May 1996)* and are discussed below.

Sample Identification Documents:

- Sample label
- Custody seals
- Chain-of-custody records
- Field notebooks
- Corrective Action Documentation

5.1 Sample Identification

All samples collected in the course of a project will be identified by a unique ten-digit sample identification number system which will include the area of concern (AOC) designation, sample matrix and location, QA/QC sample type, and sampling method/depth. That identification code will be recorded on the sample label affixed to the sample container, in the field log and on the analytical request/chain-of-custody form. The sample identification code will be used to track each sample as well as cross-reference sample data with other activities. The samples will be identified using the following system:

FORMAT: **1 2 3 4 5 6 7 8 9 0**

SOIL SAMPLE IDENTIFICATION

1 2 3 — The first three digits are for the AOC where the sample was collected. AOC code for this project is as follows: CCV

4 — This digit will represent the matrix of the sample and whether or not the sample is a duplicate of another sample. In order to keep the data consistent from project to project and facilitate data management, a master list of abbreviations for common matrices are shown on Table 5-1.

5 6 7 8 — These four digits are for the sampling location.

9 0 — The final two digits represent the depth from which the soil sample was collected. (e.g., a soil sample collected from 5 feet bgs will be recorded as 05).

Soil Sample Examples:

A. CCVSMA0105 represents a soil sample collected from the Carrier Collierville site, Main Plant Area location, boring number A01, at 5 feet bgs.

B. CCVCMA0105 represents a field duplicate of the sample in example A.

C. CCVSNA0315 represents a soil sample collected sample from the Carrier Collierville site, North Remediation Area location, boring number A03, at 15 feet bgs.

FIELD QC BLANK IDENTIFICATION

Equipment and volatile trip blanks will be identified using the same 10-digit code and will be identified using the following system:

1 2 3 — The first three digits are for the AOC where the sample was collected, as indicated above.

4 — This digit will represent the type of QC sample. A list of abbreviations for commonly collected QC samples are shown in Table 1.

5 6 7 8 — These digits indicate the month and day the QC sample was collected where the first two digits indicate the month and the second two digits indicate the day, (ex: October 23 would be written as 1023).

9 0 — The final two digits are the year the QC sample was collected.

Field Blank Examples:

A. CCVE092500 represents an equipment rinsate blank collected in Carrier Collierville on September 25, 2000.

B. CCVT110100 is the sample identifier for a trip blank collected on November 1, 2000.

Table 5-1
Sample Matrix Codes (4th digit on 10 digit sample code)

Matrix Codes		QC Codes	
S	= soil (surface, boring, and trenches)	T	= trip blank
C	= soil duplicate sample	E	= equipment rinsate blank
M	= sediment (settled, fluid-borne solids)	D	= DI system blank
N	= sediment duplicate	F	= field blank
G	= groundwater	L	= filter blank
H	= groundwater duplicate sample		
W	= surface water		
R	= surface water duplicate sample		
U	= sludge		
Y	= sludge duplicate		
A	= air		
J	= air duplicate		
Z	= liquid waste (including IDW drums)		
V	= solid waste (including IDW drums)		

5.2 Sample Labeling

A sample identification label, as shown in Appendix A, will be affixed directly to each sample container to document activities associated with collection of that specific sample. Sample labels will be completed in waterproof ink at the time of sample collection by the individual(s) collecting the samples. Specific information to be recorded on each sample label includes the project name and location, sample identification code, date and time of sample collection, type of sample (e.g., grab, composite, matrix), name of person collecting sample, preservation notations, and analyses requested.

5.3 Sample Packaging

Immediately following sample collection/labeling and chain-of-custody form completion, samples will be cooled. When samples are shipped, samples will be placed in insulated shipping containers and packed with ice or cold packs for shipment to the laboratory at the end of each day. When a local laboratory is used, samples will be placed in an insulated container, packed with ice and shuttled to the laboratory. Samples for VOC analysis will be placed in closeable plastic bags and wrapped in bubble wrap or similar packing material.

All shipping containers with materials categorized or potentially categorized as hazardous materials under U.S. Department of Transportation (USDOT) regulations will be appropriately packed and labeled for shipment. The corresponding analytical request/chain-of-custody forms enclosed in waterproof plastic bags will be enclosed in the shipping container for shipment with the samples. When samples are shipped for overnight delivery, shipping containers will be sealed with tape, and all openings will be secured with a custody seal. This custody seal, as shown in Appendix A, is placed on the shipping containers such that the containers cannot be opened without breaking the seals.

5.4 Sample Shipping

When possible, all samples will be shipped to the laboratory via courier or overnight carrier at the end of the sampling day. Each shipment will be in accordance with USDOT regulations. Prior to shipment, free water will be drained from each shipping container, the container will be repacked with ice or cold packs, and then closed and sealed. The multiple copies of the shipping manifest will be retained by the shipper and recipient laboratory as documentation of the chain-of-custody. When daily shipments are not possible (e.g., such as when work is performed on a Sunday), samples will be shipped within 48 hours of sample collection.

5.5 Chain-of-Custody

Chain-of-custody will be documented for all samples collected and analyzed in the course of this project. Chain-of-custody documentation will commence upon collecting a sample. Following completion of sample labels, analytical request/chain-of-custody form will be completed by the individuals collecting the samples. An analytical request/chain-of-custody form will accompany each sample shipment to document the transfer of custody from the time and point of collection until delivery to the laboratory for analysis. Specific information to be provided on each form includes:

- Project name and location
- Sample identification code
- Number, size, and type of sample containers
- Date, time, and location of sample collection
- Date and time of custody transfer
- Name and signature of individuals who collected the samples
- Name and signature of recipient of samples

A copy of the Chain-of-Custody form can be found in Appendix A.

5.6 Sample Analysis

The acceptance of analytical results and the control of analytical systems is based on the evaluation of quality control data. The quality control program established for the laboratory strictly adheres to the requirements of the USEPA. Procedures set forth by the USEPA will be used as a major guidance document for the QC program.

QA will also be maintained through strict adherence to the prescribed analytical procedures. Monitoring and documentation to the QA/QC efforts during the analytical effort, both in the field and in the laboratory, will be the responsibility of the Site Manager and laboratory QA/QC officer, respectively. Specific laboratory QA/QC procedures are maintained by the laboratory.

Samples will be analyzed in accordance with *Test Methods for Evaluation of Solid Waste (Physical/Chemical Methods)*, (SW-846), United States Environmental Protection Agency (USEPA) Office of Solid Waste and Emergency Response, Third Edition. Specifically, VOCs will be collected and analyzed using SW-846 Method 8260.

5.7 Sample Containers, Preservation, and Holding Times

Samples will be chemically preserved in accordance method guidelines. Table 5-2 provides information on sample container type, and size, preservation requirements, and holding times. The appropriate number of certified pre-cleaned sample containers, preservatives and trip blanks will be provided by the contracted laboratory.

Table 5-2
Sample Containers, Preservation, and Holding Times

Analytical Method	Matrix	Container Type	Sample Volume	Preservation	Holding Time
SW-846 8260B	Soil	EnCore® sampler or equivalent[a]	3 samplers	4 C	laboratory preservation within 48 hrs. Analysis within 14 days for frozen preserved sample vial
		glass	2 or 4 oz bulk	4 C	none; used for determination of soil moisture

5.8 Calibration Procedures and Preventative Maintenance

Calibration procedures and frequency for laboratory activities are described in the laboratory QA Plan. EnSafe plans to calibrate field equipment, such as pH meters and specific conductance meters, according to the procedures recommended by the manufacturer.

Sampling equipment will be employed by EnSafe during the investigation which may require preventive maintenance. This maintenance will be performed according to the manufacturer's recommendations. Records of calibration and maintenance activities for each piece of equipment will be recorded in a field log book as necessary.

5.9 Corrections to Documentation

Notebooks — As with any data logbooks, no pages may be removed for any reason. If corrections are necessary, these must be made by drawing a single line through the original entry (so that the original entry can still be read) and writing the corrected entry alongside. The correction must be initialed and dated. Some corrected errors will require a footnote explaining the correction. Corrections to errors shall be made by the individual responsible for the entries in the field logbook.

Sampling Forms — As previously stated, all sample identification tags, chain-of-custody records, and other forms must be written in indelible black ink. None of these documents is to be destroyed or thrown away, even if they are illegible or contain inaccuracies that require a replacement document. If an error is made on a document, the individual responsible for preparation of the document may make corrections by crossing a single line through the error and entering the corrected information. Any subsequent errors discovered on a document should be corrected by the person who made the entry. All corrections must be initialed and dated.

5.10 Corrective Action

During the course of any investigation, field personnel are responsible for seeing that field instruments and equipment are functioning properly and that work progresses satisfactorily. The field personnel are also responsible for ensuring that routine preventive maintenance and QC procedures are performed. If a problem is detected by field personnel, the project manager shall be notified immediately. Similarly, if a problem is identified during a routine audit by the project QA officer or the regulatory QA officer, then an immediate investigation will be undertaken and corrective action deemed necessary will be taken as early as possible.

5.11 Out-of-Control Situations

Potentially out-of-control situations include field instrument breakdown, mislabeling or loss of samples, inadvertent contamination of samples, etc. If an out-of-control event occurs, field sampling personnel shall make appropriate contacts and document any remedial efforts taken to bring field activities under control. The immediate contacts shall be the EnSafe project manager and/or the EnSafe QA officer. The EnSafe project manager shall decide whether further contacts are to be made to Carrier, EPA or the Tennessee Department of Environment and Conservation (TDEC). Formal documentation of out-of-control occurrences and any associated corrective actions recommended or initiated shall be recorded in the field logbooks.

All variances or changes from project QAP are subject to approval by the EPA remedial project manager (RPM) and the TDEC representative. If circumstances arise that require significant changes in the protocols, methods, or techniques outlined in the work plan and/or the QAP, the EPA RPM and/or the TDEC project manager may be contacted. Any EPA or TDEC alterations will be documented and implemented with the agency's written consent.

5.12 Internal QC Checks

EnSafe will conduct internal QC checks of sampling procedures and laboratory analyses. These checks will consist primarily of the preparation and submittal of blind duplicates, equipment rinsate blanks, field blanks, and trip blanks for analysis as previously described. In addition, the QA/QC Officer may elect to audit any component or phase of the data collection or analytical activities.

5.13 Deliverable Documents

Deliverable documents for this investigation will be reviewed for QA by the primary data users and secondary users specified by the Project Manager.

5.14 Site Access/Coordination

All work performed as part of this work plan will be coordinated by the Project Manager, Site Manager, and Carrier representatives. Further, all work will comply with the relevant sections of this work plan.

5.15 Site Access

Because the Site Manager is responsible for the timely completion of work in accordance with established health and safety requirements, access to active work areas will be by his/her authorization only. Access will be limited to those individuals directly involved in the performance and monitoring of project work.

Non-field visitors will be given authorized access by the Site Manager on a case-by-case basis during conduct of field activities to perform official duties such as project oversight, QA monitoring, and health and safety monitoring only. Authorized visitors will coordinate their visits with the Site Manager and designated Carrier representatives prior to arrival onsite.

To minimize health and safety risks to both visitors and project team members, all visitors will complete a site-specific health and safety briefing prior to entering the site. Once onsite, all activities by visitors will be subject to the authority of the Site Manager and designated Carrier representatives.

Certain site activities may require further access restriction based on conditions observed in the field. The decision to further restrict site access will be the responsibility of the Site Manager and designated Carrier representatives.

A

Appendix A

Sampling Forms

ENSAFE

Ensafe, Inc.

SITE NAME	DATE
ANALYSIS	TIME
	PRESERVATIVE
SAMPLE IDENTIFICATION	
PROJECT NUMBER	

ENSAFE

(800) 588-7962
MEMPHIS, TENNESSEE
CHARLESTON, SC CINCINNATI, OH DALLAS, TX JACKSON, TN KNOXVILLE, TN
LANCASTER, PA NASHVILLE, TN NORFOLK, VA PADUCAH, KY PENSACOLA, FL
CLEVELAND, OH JACKSON, MS LITTLE ROCK, AR

ENSAFE SAMPLE LABEL

DWG DATE: 02/03/00 | DWG NAME: 22780S18

ENSAFE	ENVIRONMENTAL AND SAFETY DESIGNS, INC. 5724 Summer Tree Dr. Memphis, TN 38134 OFFICIAL SAMPLE SEAL	SAMPLE #	DATE	SEAL BROKEN BY:
		SIGNATURE		DATE:
		PRINT NAME & TITLE:		

ENSAFE

(800) 588-7962
MEMPHIS, TENNESSEE
CHARLESTON, SC CINCINNATI, OH DALLAS, TX JACKSON, TN KNOXVILLE, TN
LANCASTER, PA NASHVILLE, TN NORFOLK, VA PADUCAH, KY PENSACOLA, FL
CLEVELAND, OH JACKSON, MS LITTLE ROCK, AR

ENSAFE CUSTODY SEAL

DWG DATE: 02/03/00 | DWG NAME: 2278S019

ENSAFE

800-688-7962
MEMPHIS, TENNESSEE
CHARLESTON,SC; CINCINNATI,OH; DALLAS,TX; JACKSON,TN; KNOXVILLE,TN; LANCASTER,PA; NASHVILLE,TN; NORFOLK,VA; PADUCAH,KY; PENSACOLA,FL; RALEIGH,NC; COLOGNE, GERMANY

CHAIN OF CUSTODY RECORD

PAGE _____ OF _____

PROJECT/JOB NO: _____
COC NO: _____
PO NO: _____
REL NO: _____
LAB NAME: _____

CLIENT _____ PROJECT MANAGER _____

LOCATION _____ TELE/FAX NO. _____

SAMPLERS: (SIGNATURE) _____

FIELD SAMPLE NUMBER	DATE	TIME	SAMPLE TYPE	TYPE/SIZE OF CONTAINER	PRESERVATION TEMP.	PRESERVATION CHEMICAL	NO. OF CONTAINERS	ANALYSIS REQUIRED	REMARKS

RELINQUISHER:	DATE	RECEIVER:	DATE	RELINQUISHER:	DATE	RECEIVER:	DATE
PRINTED:	TIME	PRINTED:	TIME	PRINTED:	TIME	PRINTED:	TIME
COMPANY:		COMPANY:		COMPANY:		COMPANY:	

METHOD OF SHIPMENT: _____
SHIPMENT NO. _____
SEND RESULTS TO: _____

COMMENTS: _____

ANALYTICAL DATA RECEIVED BY (INITIALS/DATE) _____

ENSCOC2
REV. 05/98

ENSAFE
CHARLESTON,SC CINCINNATI,OH DALLAS,TX JACKSON,TN KNOXVILLE,TN
LANCASTER,PA NASHVILLE,TN NORFOLK,VA PADUCAH,KY PENSACOLA,FL
CLEVELAND, OH JACKSON, MS LITTLE ROCK, AR
(800) 588-7962
MEMPHIS, TENNESSEE

ENSAFE CHAIN-OF-CUSTODY FORM

DWG DATE: 02/03/00

DWG NAME: 2278S021